Application of the Method of Moments to the Analysis of Radiation from Metal and Plasma Antennas in Conditions Typical for the Near-Earth Plasma

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This work deals with the method of moments applied to the analysis of radiation from antennas in anisotropic media such as magnetized plasmas.

The method of moments is widely used for the analysis of radiation from metal antennas in isotropic media such as vacuum. This method allows one to calculate the current distribution along the antenna wire from the integral equation that represents a boundary condition on its surface. Such antenna characteristics as an input impedance and radiation pattern may be obtained from the current distribution.

In the case of a magnetized plasma, such calculations are much more complicated because one must take account of anisotropy and dispersion. In this work, the two special cases that correspond to the typical conditions in the near-Earth plasma and allow one to simplify the calculations are considered.

The first part of this paper is based on the previous work (E. Shirokov. *Computations of the input impedance of antennas in a magnetoplasma using the method of moments.* URSI GASS 2014, doi: 10.1109/URSIGASS.2014.6929736) and deals with the application of the method of moments to the analysis of radiation from the thin metal antennas that are much shorter than the length of electromagnetic wave in a magnetized plasma. The main attention is focused on the so-called resonant frequency ranges such as the whistler frequency range. In these ranges, the real part of antenna's impedance is much greater than the respective value in vacuum because the plasma waves are effectively excited under the resonant conditions.

The problem discussed in the second part of this paper has never been considered. It deals with the method of moments applied to the analysis of radiation from a plasma-wave channel. This channel is a plasma density duct that is directed along the external magnetic field. It is formed due to ionization of a background plasma in the region of strong field of plasma waves radiated by an antenna and propagated (canalized) inside the channel under the resonant conditions. Amplitude modulation of the initial signal produces a periodic longitudinal current in the channel that allows one to consider this channel as a plasma antenna that effectively excites LF waves.

The characteristics of above-described metal and plasma antennas have been calculated using the method of moments in the case of simple geometry in a magnetized plasma. The obtained values are very close to the theoretical ones. Therefore, the method of moments may be used for the computations in the cases of more complicated geometry when a theoretical investigation is either difficult or impossible.